

REMARKS

Applicant respectfully requests reconsideration. Claims 1-4, 7-12, 14-21, 23-29, 31, 33-35, and 37-51 were previously pending in this application. Independent claims 1, 7, 15, 25, 39, and 46 have been amended. A number of the dependent claims have been amended to be consistent with the amendments to the independent claims. Claims 4, 12, 14, 21, 23, 24, 31, 35, and 51 have been cancelled. Claims 52-55 have been added. No new matter has been added. Claims 1-3, 7-11, 15-20, 25-29, 33-34, 37-50, and 52-55 are now pending for examination with claims 1, 7, 15, 25, 39, 46 and 52 being independent claims.

Request for Interview

Applicant's attorney expressed interest in having an interview with the Examiner to discuss the application. The Examiner indicated that he would be willing to contact Applicant's attorney to discuss the possibility of an interview after considering this amendment and prior to sending out another office action in the event that the application is not in condition for allowance. Applicant thanks the Examiner for that courtesy.

Claim Rejections - 35 U.S.C. §112, First Paragraph

Claims 1-4, 7-12, 14-21, 23-29, 31, 33-35 and 37-51 were rejected under 35 U.S.C. §112, first paragraph, as failing to comply with the enablement requirement.

The Office Action states that it is not clear from Applicant's original disclosure how Applicant has determined the claimed hardness data, how the hardness data is presented in "GPa" units, and what the hardness values represent.

Applicant notes that independent claim 46, and its dependent claims 47-50, do not recite a hardness. Thus, Applicant submits that this rejection should not apply to these claims. New independent claim 52, and its dependent claims 53-55, also do not recite a hardness.

Applicant has amended independent claims 1, 7, 15, 25 and 39 to clarify the meaning of the recited hardness values. These claims have been amended to include the term "nanoindentation hardness" which specifies that the hardness values were measured using a standard nanoindentation technique as described in the application (e.g., see page 13, line 23 - page 14, line 15).

Applicant is filing herewith a Declaration of Krystyn J. Van Vliet pursuant to 37 C.F.R. 1.132. Dr. Van Vliet is an assistant professor at the Massachusetts Institute of Technology who has expertise in the area of metal coatings including techniques used to characterize properties of metal coatings. Dr. Van Vliet personally carried out the nanoindentation testing described in the patent application, as well as comparative nanoindentation tests on materials described in U.S. Patent No. 5,075,175 (Brinkmann), which are discussed further below.

The Declaration states that the specification of this application provides sufficient detail such that the following would be understood by those of ordinary skill in the art upon review of the application: the meaning of "nanoindentation hardness"; the meaning of the units "GPa" (gigapascal) used in connection with the nanoindentation hardness results; and details of parameters used in obtaining the nanoindentation hardness results sufficient to enable reproduction of the invention and comparison of the processes and products of the invention to the processes and products of others. (See Declaration, paragraph 6).

In the opinion of Dr. Van Vliet, nanoindentation is a superior technique for measuring the hardness of the metal alloy coatings described in this application than conventional microhardness testing techniques (such as Brinell, Rockwell, Vickers and Knoop diamond indentation). (See Declaration, paragraph 12). Force and displacement can be measured at significantly greater resolution (e.g., microNewtons and nanometers, respectively) using nanoindentation compared to the microhardness techniques and, thus, provides a more accurate evaluation of hardness as stated in the Declaration. Moreover, the Declaration notes loads required to meet American Society of Testing and Materials (ASTM) standards of microhardness testing would result in an indentation depth that would exceed the thickness of the metal alloy coatings described in this patent application and/or exceed the depth to which substrate effects on calculated hardness are minimized.

The Declaration describes that those of ordinary skill in the art understand the nanoindentation hardness is the hardness determined from a nanoindentation technique. As noted in the Declaration, those of ordinary skill understand that nanoindentation involves applying a force to a sample with an indenter. (See Declaration, paragraph 11). The applied force is measured simultaneously with indenter displacement to provide load-displacement experimental data from which nanoindentation hardness is calculated.

The Declaration further states that nanoindentation hardness is representative of the average pressure the material can sustain beneath the indenter. (See Declaration, paragraph 11). Therefore, as known to those of ordinary skill in the art, the units for nanoindentation are expressed in units of pressure, such as GPa. As noted in the Declaration, where nanoindentation hardness is described in units of GPa, as in the patent application, those of ordinary skill would understand that experimental data is converted to hardness in GPa units via analysis of standard units of load per unit area, representing the maximum applied load normalized by the concurrent projected area of the indentation formed in the metal surface, calculated according to Oliver and Pharr (1992) Method of Instrumented Nanoindentation Data Analysis.

The Declaration further states that one of ordinary skill in the art understands that nanoindentation of a thin metal coating on a substrate, such as those described in this patent application, uses standard measurement parameters that do not need to be further qualified or described beyond the description in the patent application. (See Declaration, paragraph 13). These standard parameters include: use of a Berkovich-type pyramidal three-sided sharp indenter; use of an appropriate maximum indentation depth selected to minimize effects from the substrate (e.g., less than 33% of the coating thickness as described in the application); and, measuring a sufficient number of samples to provide a standard deviation of less than 10%. One of ordinary skill in the art would also understand that there is no need to provide the maximum load as a parameter for nanoindentation because load and displacement are measured simultaneously throughout the technique, as noted above.

One of ordinary skill in the art understands that nanoindentation uses standard sample preparation techniques for measuring metal alloy coatings (such as those described in this patent application) that do not need to be further qualified or described beyond the description in the patent application, according to the Declaration. (See Declaration, paragraph 14).

For these reasons and those further stated in the Declaration of Dr. Van Vliet, the nanoindentation hardness values are described in the specification in a way that enables one skilled in the art to make and/or use the invention. Thus, Applicant submits that the claims are sufficiently enabled. Accordingly, Applicant respectfully requests withdrawal of the rejection of claims 1-4, 7-12, 14-21, 23-29, 31, 33-35, and 37-45.

As noted above, claims 46-50 do not recite any hardness values and, thus, Applicant also respectfully requests withdrawal of the rejection of these claims.

Claim Rejections - 35 U.S.C. §112, Second Paragraph

Claims 1-4, 7-12, 14-21, 23-29, 31, 33-35, and 37-51 were rejected under 35 U.S.C. §112, second paragraph as being indefinite.

The Office Action states that it is not clear from Applicant's original disclosure what the hardness values represent and, thus, the claims are indefinite.

Applicant notes that independent claim 46, and its dependent claims 47-50, do not recite a hardness. Thus, Applicant submits that this rejection should not apply to these claims. New independent claim 52, and its dependent claims 53-55, also do not recite a hardness.

As noted above, Applicant has amended independent claims 1, 7, 15, 25 and 39 to clarify the meaning of the recited hardness values. These claims have been amended to include the term "nanoindentation hardness" which specifies that the hardness values were measured using a standard nanoindentation technique as described on page 13, lines 23- page 14, line 15.

As described above in connection with the enablement rejection and further stated in the Declaration of Dr. Van Vliet, the specification of this application provides sufficient detail such that the following would be understood by those of ordinary skill in the art upon review of the application: the meaning of "nanoindentation hardness"; the meaning of the units "GPa" (gigapascal) used in connection with the nanoindentation hardness results; and details of parameters used in obtaining the nanoindentation hardness results sufficient to enable reproduction of the invention and comparison of the processes and products of the invention to the processes and products of others. (See Declaration, paragraph 6).

For these reasons, those further described above in connection with the enablement rejection and those further stated in the Declaration of Dr. Van Vliet, the nanoindentation hardness values are described in the specification in a way that one of ordinary skill in the understands their meaning. Thus, Applicant submits that the claims are sufficiently definite. Accordingly, Applicant respectfully requests withdrawal of the rejection of claims 1-4, 7-12, 14-21, 23-29, 31, 33-35, and 37-45.

As noted above, claims 46-50 do not recite any hardness values and, thus, Applicant also respectfully requests withdrawal of the rejection of these claims.

Rejection of Claims 1-3 and 37-40 under 35 U.S.C. §102(b)

Claims 1-3 and 37-40 were rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 3,503,721 (Lupfer).

Independent claim 1 has been amended to include the recitation of claim 4, which does not stand rejected on this ground, as well as further limitations. Lupfer fails to teach or suggest the electrical connector recited in amended claim 1 which comprises an electrically conductive material and a non-electroplated coating consisting of 3 wt% to about 20 wt% silver and the balance tin, wherein the coating has a thickness in the range of from 0.00001" to 0.001".

Independent claim 39 has also been amended to include the thickness recitation of claim 4 (which does not stand rejected on this ground), as well as further limitations. Lupfer fails to teach or suggest a process for forming an electrical connector as recited in amended claim 39 which comprises immersing a substrate material in a bath to form a non-electroplated coating layer having a thickness in the range of from 0.0001 inch to 0.001 inch and forming an electrical connector from the coated substrate material.

Applicant also disagrees with the assertion in the Office Action that the claimed hardness would be inherent in the Lupfer solder composition for the reasons previously stated in the prosecution history. It is noted that for a proper rejection under §102 to be made, there must be evidence that the prior art *necessarily inherently* discloses the claimed invention. Lupfer is entirely silent regarding hardness and there is no suggestion that the claimed hardness range is inherent in the Lupfer composition.

Because Lupfer does not disclose or make obvious each limitation of independent claims 1 and 39, these claims are patentable over Lupfer. Claims 2-3 depend from claim 1 and claims 37-38, and 40 depend from claim 39. These claims, therefore, are also patentable over Lupfer.

Accordingly, Applicant respectfully requests withdrawal of the rejection on this ground.

Rejection of Claims 1-4 and 51 under 35 U.S.C. §102(b)

Claims 1-4 and 51 were rejected under 35 U.S.C. §102 (b) as being anticipated by U.S. Patent No. 5,902,472 (the Arai '472 patent).

The Arai '472 patent fails to teach or suggest a non-electroplated coating as recited in claim 1. Arai uses an electroplating process and, thus, the coatings fail to meet the "non-electroplated" claim limitation. The Office Action notes that there had been no factual evidence of record that coatings produced by all other processes than electroplating processes are physically and patentably distinct from the coatings of the Arai '472 patent. As noted in the Declaration of Dr. Van Vliet, filed herewith, electroplated coatings have a different microstructure than non-electroplated coatings. (See Declaration, paragraph 8). Furthermore, as noted in the Declaration, one of ordinary skill in the art would be able to distinguish an electroplated coating from a non-electroplated coating by examining the microstructure. Thus, the term "non-electroplated" should be given patentable weight.

The Office Action states that the Arai coatings are subjected to melting (e.g., See solderability tests in the Embodiments) which would leave the coatings with a final microstructure consistent with melted tin-silver alloy and, not a microstructure associated with electroplating. However, even if this is true, the coated test structures in these Embodiments would fail to meet a number of other claim limitations. For example, the coated test structures are not an "electrical connector" as recited in the claims. Also, there is no suggestion that the coated test structures would have the thickness limitation recited in the claims.

Applicant also disagrees with the assertion in the Office Action that the claimed hardness would be inherent in the Arai electroplated coatings for the reasons previously stated in the prosecution history. It is noted that for a proper rejection under §102 to be made, there must be evidence that the prior art *necessarily inherently* discloses the claimed invention. The Arai '472 patent is entirely silent regarding hardness and there is no suggestion that the claimed hardness range is inherent in the Arai electroplated coatings.

Because the Arai '472 patent does not disclose or make obvious each limitation of independent claim 1, this claim is patentable over the Arai '472 patent. Claims 2-3 depend from claim 1 and, thus, are also patentable over the Arai '472 patent. Claims 4 and 51 have been cancelled.

Accordingly, Applicant respectfully requests withdrawal of the rejection on this ground.

Rejection of Claims 1-4, 7-12, 14-18, 20-21, 23-28, 31, 33-35, and 51 under 35 U.S.C. §102(b)

Claims 1-4, 7-12, 14-18, 20-21, 23-28, 31, 33-35, and 51 were rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 5,948,235 (the Arai '235 patent).

Independent claim 1 recites a coating the consists of silver and tin. In contrast, the coatings in the Arai '235 patent comprise tin, silver and at least one of copper or bismuth. Arai emphasizes the presence of at least one of copper and bismuth which are excluded by claim 1 (See, e.g., column 1, lines 39-46). Thus, the Arai '235 patent fails to disclose, and even teaches away from, the coating compositions recited in independent claim 1.

Independent claim 7 recites that the coating consists of silver, at least one addition selected from the group consisting of silicon, magnesium, iron, manganese, zinc, and antimony, and the balance tin. As noted above, the Arai '235 patent discloses coatings that comprise tin, silver, and at least one of bismuth and copper. Arai emphasizes the presence of at least one of copper and bismuth which are excluded by claim 7 (See, e.g., column 1, lines 39-46). Thus, the Arai '235 patent fails to disclose, and even teaches away from, the coating compositions recited in independent claim 7.

The Arai '235 patent also fails to teach or suggest a non-electroplated coating as recited in each of the independent claims that stand rejected on this ground (claims 1, 7, 15, and 25). Arai uses an electroplating process and, thus, the coatings fail to meet the "non-electroplated" claim limitation. The Office Action notes that there had been no factual evidence of record that coatings produced by all other processes than electroplating processes are distinct from the coatings of the Arai '235 patent. As noted in the Declaration of Dr. Van Vliet, filed herewith, electroplated coatings (such as those described in the Arai patents) have a different microstructure than non-electroplated coatings. Furthermore, as noted in the Declaration, one of ordinary skill in the art would be able to distinguish an electroplated coating from a non-electroplated coating by examining the microstructure. Thus, the term "non-electroplated" should be given patentable weight.

The Office Action states that the Arai coatings are subjected to melting (e.g., see solderability tests in the Embodiments) which would leave the coatings with a final

microstructure consistent with melted tin-silver alloy and, not a microstructure associated with electroplating. However, even if this is true, the coated test structures in these Embodiments would fail to meet a number of claim limitations. For example, the coated test structures are not an “electrical connector” as recited in the claims. Also, there is no suggestion that the coated test structures would have the claimed thickness limitation.

Applicant also disagrees with the assertion in the Office Action that the claimed hardness would be inherent in the Arai electroplated coatings for the reasons previously stated in the prosecution history. It is noted that for a proper rejection under §102 to be made, there must be evidence that the prior art *necessarily inherently* discloses the claimed invention. The Arai ‘235 patent is entirely silent regarding hardness and there is no suggestion that the claimed hardness range is inherent in the Arai electroplated coatings.

Because the Arai ‘235 patent does not disclose or make obvious each limitation of independent claims 1, 7, 15, and 25, these claims are patentable over the Arai ‘235 patent. The remaining claims that stand rejected on this ground depend from one of these independent claims (or have been cancelled) and, thus, are also patentable over the Arai ‘235 patent.

Accordingly, Applicant respectfully requests withdrawal of the claim rejections on this ground.

Rejection of Claims 7-12, 14-18, 20-21, 23-28, 31, 33-35, 37-41, 46-47, and 50-51

Claims 7-12, 14-18, 20-21, 23-28, 31, 33-35, 37-41, 46-47, and 50-51 were rejected under 35 U.S.C. §102(b) as being anticipated by JP Pub. 2000-080460 (Harada).

Harada fails to teach or suggest an electrical connector as recited in the independent claims.

Independent claim 7 recites that the coating consists of silver; at least one addition selected from the group consisting of silicon, magnesium, iron, manganese, zinc, and antimony; and the balance tin. Harada discloses coatings that comprise tin, silver, and 0.01 to 2.0% copper. Harada emphasizes the presence of copper which is excluded by claim 7 (See, e.g., paragraph 8).

Independent claim 15 recites that the coating consists of silver, copper in a range from 2.5 wt% to 5.0 wt%, and the balance tin. As noted above, Harada discloses coatings that

comprise tin, silver, and 0.01 to 2.0% copper. Harada emphasizes the criticality of using between 0.01 to 2.0% copper – a range which is excluded by claim 15 (See, e.g., paragraph 8).

Independent claim 39 recites the step of preparing a bath consisting of 3.0 wt% to 20 wt% silver and the balance tin. Harada discloses a bath that comprises tin, silver, and 0.01 to 2.0% copper and emphasizes the presence of copper which is excluded by claim 39 (See, e.g., paragraph 8).

Independent claim 46 recites the step of preparing a bath consisting of 3.0 wt% to 20 wt% silver, at least one addition selected from the group consisting of bismuth, silicon, magnesium, iron, manganese, zinc, and antimony; and the balance tin. As noted above, Harada discloses a bath that comprises tin, silver, and 0.01 to 2.0% copper and emphasizes the presence of copper which is excluded by claim 46 (See, e.g., paragraph 8).

Thus, Harada fails to disclose, and even teaches away from, the coating compositions recited in independent claims 7 and 15, as well as the bath compositions recited in independent claims 39 and 46.

For at least these reasons, independent claims 7, 15, 25, 39 and 46 are patentable over Harada. The remaining pending claims that stand rejected on this ground depend from one of these independent claims and, thus, are patentable over Harada for at least this reason.

Accordingly, Applicant respectfully requests withdrawal of the rejection on this ground.

Rejection of Claims 1-4, 7-12, 14-21, 23-29, 31, 33-35, and 37-51 under 35 U.S.C. §103(a)

Claims 1-4, 7-12, 14-21, 23-29, 31, 33-35, and 37-51 were rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 5,075,176 (Brinkmann) in view of Applicant's disclosure of the prior art.

Independent claim 46 recites a process for forming an electrical connector that comprises a step of immersing an electrically conductive substrate material in a bath for a resident time period of from 0.2 to 10 seconds to form a coating on the substrate material. Brinkmann is entirely silent as to bath resident time. The Office Action states that optimizing this time would be within the level of ordinary skill in the art. However, there is no teaching in Brinkmann (or any other cited reference) that suggests a recognition that resident time is an important parameter, much less a teaching how to select a residence time as claimed which produces a

coating having the desired characteristics (e.g., hardness) described in the present application. Thus, independent claim 46 is not obvious in view of Brinkmann.

Each of the independent claims uses “consisting of” language to define specific coating and bath compositions. Independent claims 1 and 39 recite compositions that consist of silver (3-20 wt%) and tin. Independent claims 7, 15, 25 and 46 recite compositions that consist of silver (3-20 wt%), tin and a specific list of additives. There are only four distinct compositions claimed (compositions of (1) claims 1 and 39; (2) claims 7 and 46; (3) claim 15; and (4) claim 25), none of which are open to additional elements.

Though Applicant recognizes that Brinkmann discloses a list of possible elements and ranges, some of which overlap with various claim elements, Applicant submits that it is not a fair reading of Brinkmann to conclude that the specific claimed compositions are obvious in view of Brinkmann. Brinkmann teaches an alloy that contains tin, possibly lead, and at least one element selected from a group of 14 elements. This teaching covers on the order of 10^{10} possible compositions. It is unreasonable that this extremely broad teaching would render obvious the four distinct claimed compositions. Not surprisingly, the only examples disclosed in Brinkmann teach compositions that are excluded by each of the independent claims.

Furthermore, as noted in the Declaration of Dr. Van Vliet, the Brinkmann specification teaches away from the claimed silver content ranges (i.e., 3-20 wt%) in the claimed compositions. It is a stated goal of Brinkmann to keep the materials’ melting temperature as low as possible (see, e.g., Column 2, lines 33-35), which increase the solderability of the material – a further stated goal of Brinkmann, (e.g., see column 2, lines 46-47). Increasing the silver content of the Brinkmann compositions (within the claimed range) increases melting temperature. The compositions described in Brinkmann’s examples include, at most, a silver content of 1%. One of ordinary skill in the art, therefore, would not have been motivated to increase the silver content to the claimed range in view of the goal in Brinkmann to keep the melting temperature as low as possible.

Moreover, there is no teaching in Brinkmann (or any of the other prior art relied upon in the Office Action) that increasing silver content would in any way increase hardness, as noted in the Declaration. Thus, a desire for harder material would not have motivated one of skill in the art to increase the silver content of the compositions described in Brinkmann.

Also, the specific claimed compositions when combined with the recited nanoindentation hardness values are not obvious in view of Brinkmann. At the request of the Applicant, Dr. Van Vliet conducted comparative hardness measurements between the composition described in Example 1 of Brinkmann (in the form of both castings and coatings) and compositions described and claimed in this patent application (in the form of coatings). The details of the testing are described further in the Declaration.

The nanoindentation hardness of the composition (Sn-1%: Ag : 0.03%:P) disclosed in Example 1 of Brinkmann was 0.28 GPa for the coating composition and 0.20 GPa for the casting composition. As stated in the Declaration of Dr. Van Vliet, the claimed nanoindentation hardness values of 0.32 GPa to 0.41 GPa are significantly greater than these nanoindentation hardness values for the Brinkmann coating and casting compositions. (See Declaration, paragraphs 7 and 21.)

Furthermore, the nanoindentation hardness of the Brinkmann coating and casting compositions are respectively 13% and 65% lower than the nanoindentation hardness value determined if one extrapolates the data obtained on coatings of the present invention to a composition having 1% silver (Sn-1% : Ag). As stated in the Declaration of Dr. Van Vliet, this difference is also significant. (See Declaration, paragraph 21.)

Thus, both the claimed and extrapolated nanoindentation hardness values are significantly different than the nanoindentation hardness values of the measured Brinkmann compositions.

For at least these reasons, the claims rejected on this ground are not obvious in view of Brinkmann. Accordingly, Applicant respectfully requests withdrawal of this rejection.

New Claims

Independent claim 52 and dependent claims 53-55 have been added. Independent claim 52 is similar to independent claim 46, though it recites a different bath composition (a bath consisting of 3.0 wt% to 20 wt% silver and the balance tin).

Claim 52 does not recite a hardness value, so the 35 U.S.C. §112 rejections are not applicable.

Claim 52 is patentable over Lupfer, at least, because Lupfer fails to teach or suggest the specific processing steps including the bath resident time and forming an electrical connector.

Claim 52 is patentable over the Arai '472 and '235 patents, at least, because these patents fail to teach or suggest preparing a bath and immersing a substrate in the bath, or the recited bath resident time.

Claim 52 is patentable over Harada, at least, because the bath composition consists of silver and tin, while Harada requires the presence of copper in the bath composition.

Claim 52 is patentable over Brinkmann, at least, because Brinkmann does not make obvious to the claimed residence time (as described above in connection with claims 46) and does not make obvious the bath composition.

Accordingly, new independent claim 52, and its dependent claims, are patentable in view of the cited references.

CONCLUSION

A Notice of Allowance is respectfully requested. The Examiner is requested to call the undersigned at the telephone number listed below if this communication does not place the case in condition for allowance.

If this response is not considered timely filed and if a request for an extension of time is otherwise absent, Applicant hereby requests any necessary extension of time. If there is a fee occasioned by this response, including an extension fee, that is not covered by an enclosed check, please charge any deficiency to Deposit Account No. 23/2825.

Respectfully submitted,

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